Stellar family in crowded, violent neighborhood proves to be surprisingly normal

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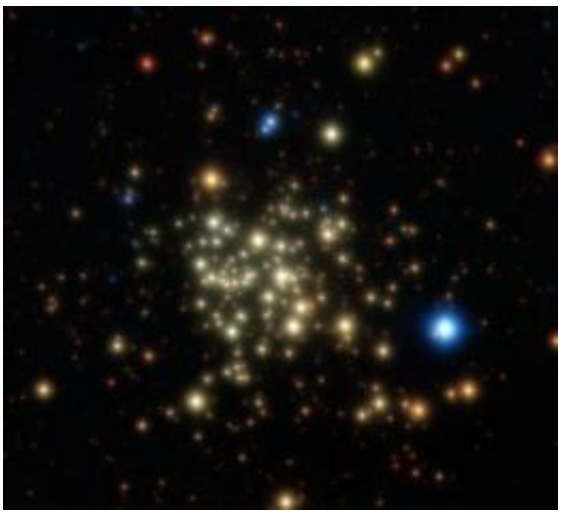

This image of the Arches Cluster of young, massive stars was obtained with NACO on ESO's Very Large Telescope. The field of view is 28 arcseconds. North is up and east is to the left. This image is a composite of infrared images obtained through J, H and K filters. The stars appear as bright cores surrounded by faint diffuse halos. This is typical of images obtained by adaptive optics instruments. The halo corresponds to light that was not fully corrected for the blurring effects of the Earth's atmosphere. Credit: ESO/P. Espinoza

The massive Arches Cluster is a rather peculiar star cluster. It is located 25 000 light-years away towards the constellation of Sagittarius (the Archer), and contains about a thousand young, massive stars, less than

2.5 million years old [1]. It is an ideal laboratory to study how massive stars are born in extreme conditions as it is close to the centre of our Milky Way, where it experiences huge opposing forces from the stars, gas and the supermassive black hole that reside there. The Arches Cluster is ten times heavier than typical young star clusters scattered throughout our Milky Way and is enriched with chemical elements heavier than helium.

Using the NACO adaptive optics instrument on ESO's Very Large Telescope, located in Chile, astronomers scrutinised the cluster in detail. Thanks to adaptive optics, astronomers can remove most of the blurring effect of the atmosphere, and so the new NACO images of the Arches Cluster are even crisper than those obtained with telescopes in space. Observing the Arches Cluster is very challenging because of the huge quantities of absorbing dust between Earth and the Galactic Centre, which visible light cannot penetrate. This is why NACO was used to observe the region in near-infrared light.

The new study confirms the Arches Cluster to be the densest cluster of massive young stars known. It is about three light-years across with more than a thousand stars packed into each cubic light-year — an extreme density a million times greater than in the Sun's neighbourhood.

Astronomers studying clusters of stars have found that higher mass stars are rarer than their less massive brethren, and their relative numbers are the same everywhere, following a universal law. For many years, the Arches Cluster seemed to be a striking exception.

"With the extreme conditions in the Arches Cluster, one might indeed imagine that stars won't form in the same way as in our quiet solar neighbourhood," says Pablo Espinoza, the lead author of the paper reporting the new results. "However, our new observations showed that the masses of stars in this cluster actually do follow the same universal

law".

In this image the astronomers could also study the brightest stars in the cluster. "The most massive star we found has a mass of about 120 times that of the Sun," says co-author Fernando Selman. "We conclude from this that if stars more massive than 130 solar masses exist, they must live for less than 2.5 million years and end their lives without exploding as supernovae, as massive stars usually do."

The total mass of the cluster seems to be about 30 000 times that of the Sun, much more than was previously thought. "That we can see so much more is due to the exquisite NACO images," says co-author Jorge Melnick.

[1] The name "Arches" does not come from the constellation the cluster is located in (Sagittarius, i.e., the Archer), but because it is located next to arched filaments detected in radio maps of the centre of the Milky Way.

More information: This research was presented in a paper to appear in *Astronomy and Astrophysics* (The massive star Initial Mass Function of the Arches Cluster, by P. Espinoza et al.).

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